

Not
Filing

Hydraulics

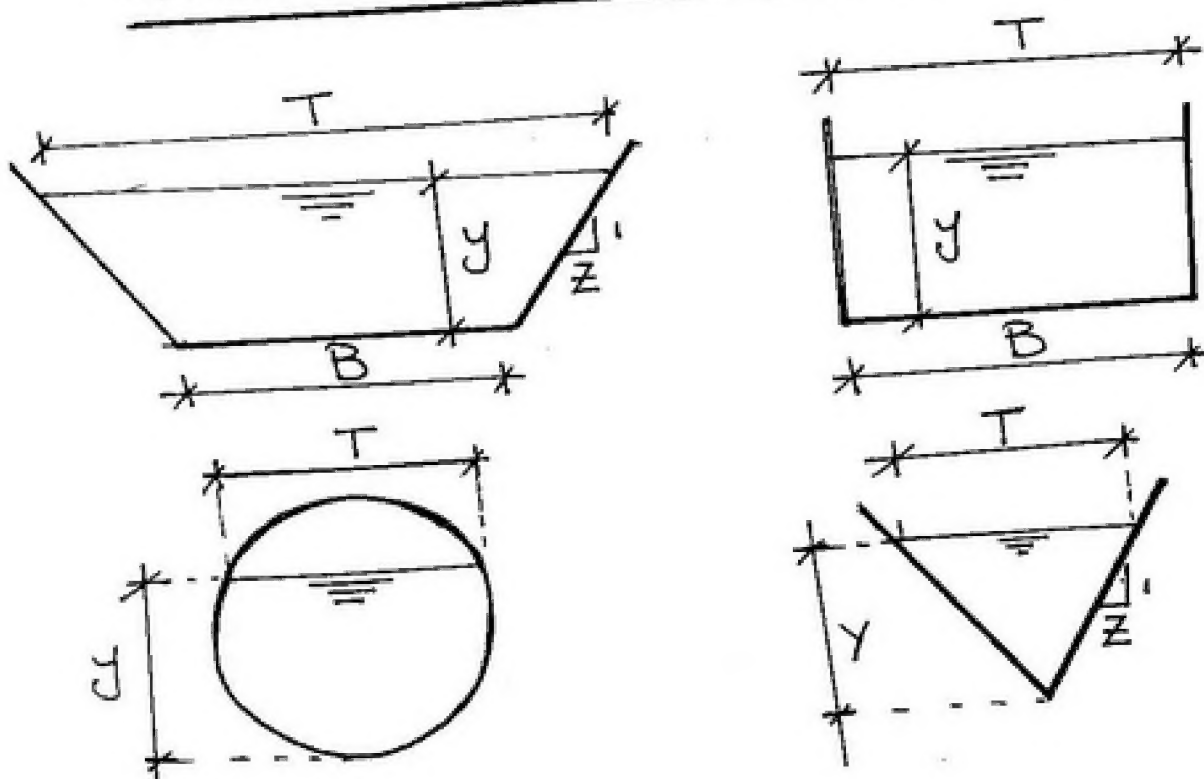
3rd Year civil

First Term (2009 - 2010)

Chapter ()

2009 - 2010

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

Ch(3): Geometric properties
of open channel- Geometric elements of channel section: B : bottom width of section. y : water depth in section. T : top width of section

\bar{y}_h : mean hydraulic depth = $\frac{A}{T}$

A : area of section.

P : perimeter of section.

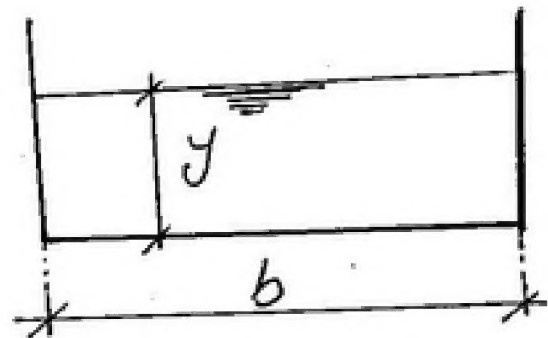
R : Hydraulic radius = $\frac{A}{P}$

Z : Section factor = $A \times \sqrt{\bar{y}_h}$

Very wide section :

يسمى المقطاع عريضاً جداً
إذا كان

$$b \geq 10y$$



$$A = b \times y, \quad P = b + 2y$$

$$R = \frac{A}{P} = \frac{b \cdot y}{b + 2y}$$

$$R = \frac{b}{\frac{b}{y} + z}$$

$$y \rightarrow \infty$$

$$\boxed{R = \frac{b}{z}}$$

Best Hydraulic section (B.H.S)

القَطَاع الهيدروليكي الأمثل

يتمتع بطريقة على أنه القَطَاع الذي يعطي أقصى
تصرف مع أقل محيط صلب عند ثبات
مساحة القَطَاع وسيله (S) ومعامل الخسوفه
داخله .

بعض الملاحظات لكلمه B.H.S

- most economical section .
- section with minimum Lining .
- section of max discharge .
- section of min. excavation .
- section with min slope .

For (b) is big value divide by (b)

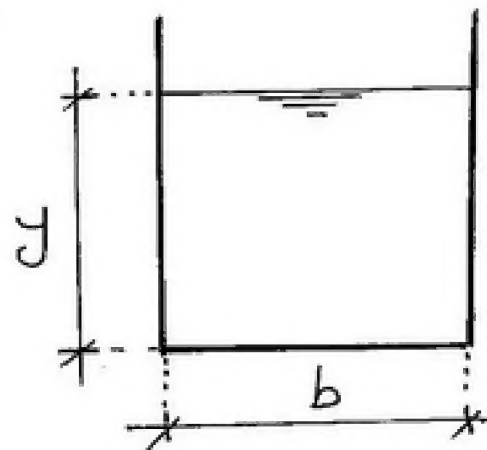
$$\therefore R = \frac{y}{1 + \frac{2y}{b}} \quad b \rightarrow \infty$$

$$\therefore \boxed{R = y}$$

Very deep section:

بسیار لفظ عمیق
اذا كان

$$\boxed{y \gg 10b}$$



$$A = b \cdot y, \quad P = b + 2y$$

$$R = \frac{A}{P} = \frac{b \cdot y}{b + 2y}$$

Divide by (y)

Steps to prove B.H.S:خطوات عمل إقطاء الصيروليلى الشمل

- ١- كتابة معادلة مساحة المحيط للقطاء .
- ٢- مع معادلة مساحة قفل على متغير بدلالة الشخر .
- ٣- نفوهم عن التغيرات فى معادلة المحيط
- ٤- نفاضل معادلة المحيط ونساويها بالصفر $\frac{dp}{d?} = 0$
- ٥- نوجد العلاقة النهائية .

Rectangular section:

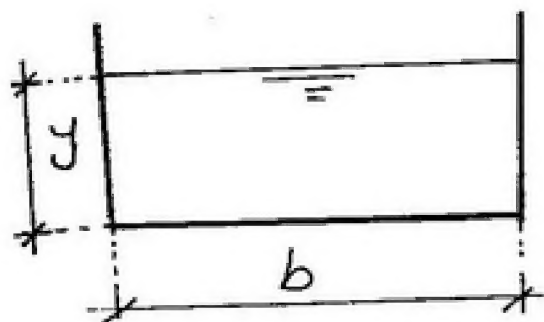
$$- A = b \times y \quad (1)$$

$$- P = b + 2y \quad (2)$$

from (1)

$$b = \frac{A}{y}$$

subis. in (2)



$$P = \frac{A}{y} + zy$$

$$\text{for B.H.S } \frac{dP}{dy} = 0$$

$$0 = -\frac{A}{y^2} + z$$

$$\frac{A}{y^2} = z \Rightarrow A = zy^2$$

$$b \cdot y = zy^2$$

$$b = zy$$

$$\text{for } R = \frac{A}{P} = \frac{b \cdot y}{b + zy}$$

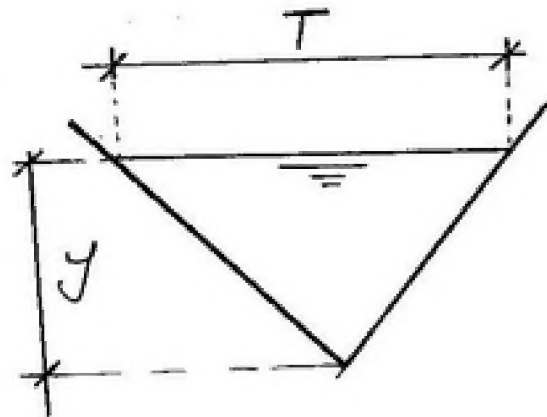
$$R = \frac{zy \times y}{zy + zy} = \frac{zy^2}{4y}$$

$$R = \frac{y}{2}$$

Triangular section:

$$- A = \frac{1}{2} \cdot T \cdot y \quad (1)$$

$$- P = 2 \sqrt{\left(\frac{T}{2}\right)^2 + y^2} \quad (2)$$



from (1)

$$T = \frac{2A}{y}$$

subis. in (2)

$$P = 2 \sqrt{\left(\frac{2A}{2y}\right)^2 + y^2} = 2 \sqrt{\frac{A^2}{y^2} + y^2}$$

$$= 2 \sqrt{\frac{A^2 + y^4}{y^2}}$$

$$P = \frac{2}{y} \sqrt{A^2 + y^4}$$

$$\text{for B.H.S} \quad \frac{dP}{dy} = 0$$

$$0 = \frac{2}{y} \times \frac{4y^3}{2\sqrt{A^2+y^4}} - \sqrt{A^2+y^4} \times \frac{2}{y^2}$$

$$\frac{4y^2}{\sqrt{A^2+y^4}} \quad \xrightarrow{=} \quad \frac{2\sqrt{A^2+y^4}}{y^2}$$

$$\therefore 4y^4 = 2(A^2+y^4)$$

$$4y^4 = 2A^2 + 2y^4$$

$$2y^4 = 2A^2$$

$$y^4 = A^2$$

بأخذ جذر الطرفين

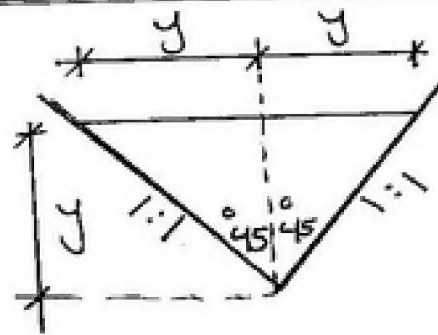
$$\therefore \boxed{y^2 = A}$$

subis in ①

$$\frac{T \cdot y}{2} = y^2 \Rightarrow$$

$$\therefore \boxed{T = 2y}$$

يكون المقطاع لـ B.H.S
إذا كانت زاوية رأس
المثلث (90°) أو أن
الميل الجانبي لـ $(1:1)$

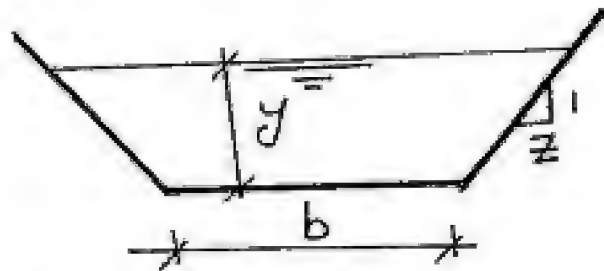


$$\therefore R = \frac{A}{P} = \frac{\frac{2y^2}{2}}{2\sqrt{2y^4}}$$

$$R = \frac{y^3}{2\sqrt{2y^4}}$$

$$R = \frac{y}{2\sqrt{2}}$$

Trapezoidal section



$$- A = (b + zy) y \rightarrow \textcircled{1}$$

$$- P = b + zy \sqrt{1 + z^2} \rightarrow \textcircled{2}$$

from $\textcircled{1}$

$$b = \frac{A}{y} - zy$$

sub's. in $\textcircled{2}$

$$\therefore P = \frac{A}{y} - zy + zy \sqrt{1 + z^2}$$

for $z = \text{Const.}$:

$$\text{for B.H.S} \quad \frac{dP}{dy} = 0$$

$$0 = -\frac{A}{y^2} - z + z \sqrt{1+z^2}$$

$$\therefore z \sqrt{1+z^2} = \frac{A}{y^2} + z \longrightarrow (3)$$

From (1) in (3)

$$2 \sqrt{1+z^2} = \frac{(b+zy)y}{y^2} + z$$

$$2 \sqrt{1+z^2} = \frac{(b+zy)y + zy^2}{y^2}$$

$$2y^2 \sqrt{1+z^2} = b \cdot y + 2zy^2$$

Divide by y

$$\boxed{2y \sqrt{1+z^2} = b + 2zy} \longrightarrow (4)$$

$$\text{for } R = \frac{A}{P} = \frac{(b+zy)y}{b+2y \sqrt{1+z^2}}$$

$$R = \frac{(b+zy)y}{b+b+2zy} = \frac{\cancel{(b+zy)}y}{2(\cancel{b+zy})}$$

$$\boxed{R = \frac{y}{2}}$$

For $y = \text{Const}$ and Z Variable :-

$$P = \frac{A}{y} - Zy + Zy\sqrt{1+Z^2}$$

for B.H.S $\frac{dP}{dZ} = 0$ for Const y

$$0 = 0 - y + Zy \times \frac{Z}{\sqrt{1+Z^2}}$$

$$y = \frac{2Zy}{\sqrt{1+Z^2}}$$

$$2Z = \sqrt{1+Z^2}$$

بتربيع الطرفين

$$4Z^2 = 1 + Z^2$$

$$3Z^2 = 1$$

$$Z^2 = \frac{1}{3} \Rightarrow$$

$$Z = \frac{1}{\sqrt{3}}$$

Circular section:

$$\therefore A = A_1 + A_2$$

$$\therefore A_1 = \frac{1}{2} \left(\frac{d}{2}\right)^2 \times \sin(360 - \theta)$$

$$A_1 = -\frac{d^2}{8} \sin \theta$$

$$A_2 = \frac{\pi d^2}{4} \times \frac{\theta}{360}$$

$$= \frac{\pi d^2}{4} \times \frac{\theta}{2 \times 180}$$

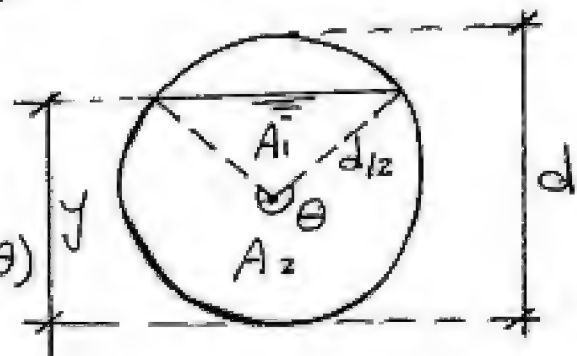
$$\therefore \frac{\pi \theta}{180} = \theta_r$$

$$\therefore A_2 = \frac{d^2}{8} \theta_r$$

$$\therefore A = \frac{d^2}{8} \theta_r - \frac{d^2}{8} \sin \theta$$

$$\therefore A = \frac{d^2}{8} (\theta_r - \sin \theta) \longrightarrow \textcircled{1}$$

$$\therefore \rho = \pi \cdot d \times \frac{\theta}{360}$$



$$A \begin{cases} \frac{\pi}{4} d^2 \rightarrow 360^\circ \\ A^2 \rightarrow \theta \end{cases}$$

$$P \begin{cases} \pi d \rightarrow 360^\circ \\ p \rightarrow \theta \end{cases}$$

$$\therefore P = \frac{\pi \theta \cdot d}{180 \times 2}$$

$$P = \frac{d}{2} \cdot \theta_r \longrightarrow (2)$$

From (1)

$$d = \sqrt{\frac{8A}{\theta_r - \sin \theta}}$$

subis in (2)

$$P = \frac{\theta_r}{2} \sqrt{\frac{8A}{\theta_r - \sin \theta}}$$

$$\therefore P = \frac{1}{2} \sqrt{\frac{8A \theta_r^2}{\theta_r - \sin \theta}}$$

$$\text{for B. H. S } \frac{dP}{d\theta} = 0$$

$$0 = \frac{1}{2} \times \frac{1}{2 \sqrt{\frac{8A \theta_r^2}{\theta_r - \sin \theta}}} \times \frac{8A \theta_r^2 \times (1 - \cos \theta) - (\theta_r - \sin \theta) \times 6A \theta_r}{(\theta_r - \sin \theta)^2}$$

$$\therefore \cancel{8A} \theta_r^2 (1 - \cos \theta) = \frac{2}{\cancel{16A}} \theta_r (\theta_r - \sin \theta)$$

$$\therefore \boxed{\theta r(1 - \cos \theta) = 2(\theta r - r \sin \theta)}$$

by trial. $\theta = \pi = 180^\circ$

for $R = \frac{A}{P}$

$$\therefore \boxed{R = \frac{d}{4}}$$

Section	Condition for B.H.S
Rectangular	$b = 2y$, $R = y/2$
Triangular	$Z = 1$, $R = y/2\sqrt{2}$
Trapezoidal	$\frac{Z_{\text{const}}}{y_{\text{const}}} \cdot R = y/2$ $Z = 1/\sqrt{3}$
Circular	$\theta r = \pi$, $\theta = 180$ $R = d/4$

[]



for any circular section
to get

V_{max}

$$P \cdot \frac{dA}{d\theta} = A \times \frac{dP}{d\theta}$$

Q_{max}

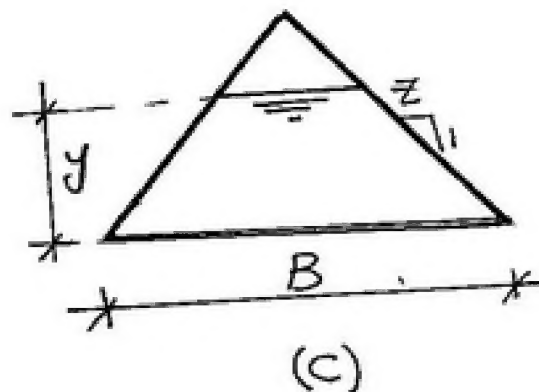
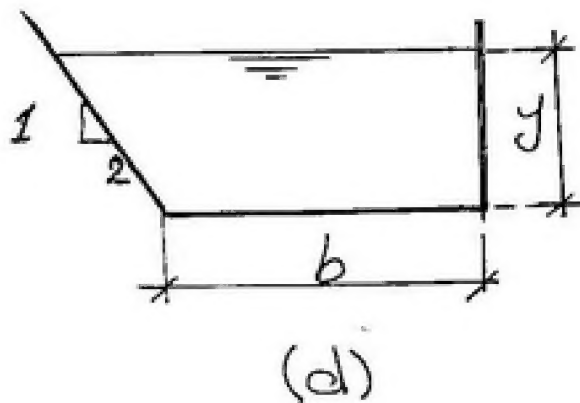
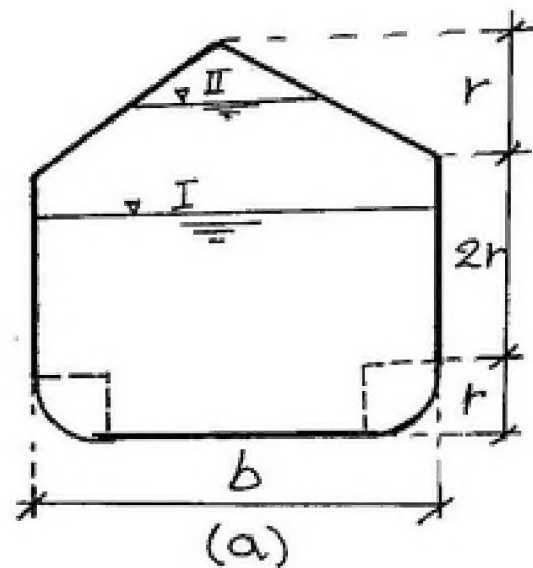
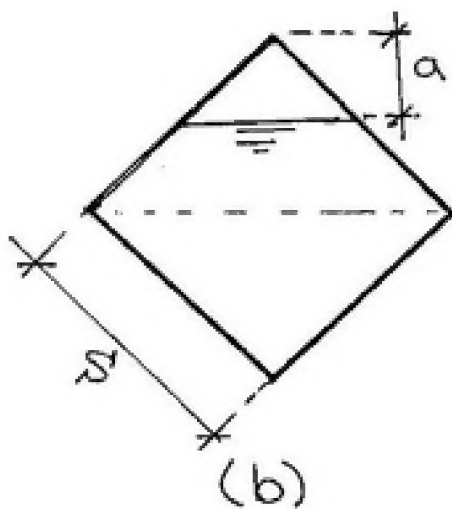
$$2.5 P \cdot \frac{dA}{d\theta} = A \cdot \frac{dP}{d\theta}$$

(Manning)

$$3 P \cdot \frac{dA}{d\theta} = A \cdot \frac{dP}{d\theta}$$

(Chezy)

For the following section find the
Conditions for B.H.S



(a): Stage I:

$$A = A_1 + A_2 + 2A_3$$

$$- A_1 = 2br$$

$$- A_2 = (b - 2r)r$$

$$= br - 2r^2$$

$$- A_3 = \frac{\pi r^2}{4} \times 2 = 1.57r^2$$

$$A_t = 2br + br - 2r^2 + 1.57r^2$$

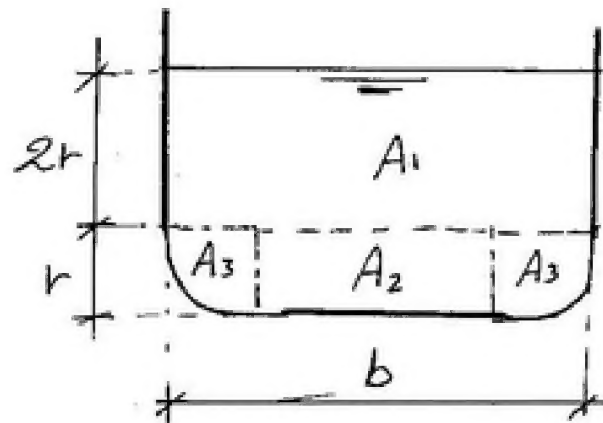
$$\therefore A_t = 3br - 0.43r^2 \longrightarrow \textcircled{1}$$

$$P = 4r + b - 2r + \frac{2\pi r}{2}$$

$$\therefore P = 5.14r + b \longrightarrow \textcircled{2}$$

from $\textcircled{1}$

$$b = \frac{A + 0.43r^2}{3r} = \frac{A}{3r} + 0.14r$$



subis. in (2)

$$\therefore P = 5.28 r + \frac{A}{3r}$$

for B.H.S $\frac{dP}{dr} = 0$

$$0 = 5.28 - \frac{A}{3r^2}$$

$$\therefore \frac{A}{3r^2} = 5.28$$

$$\therefore A = 15.84 r^2$$

$$\therefore 3br - 0.43 r^2 = 15.84 r^2$$

$$3br = 16.27 r^2$$

$$\therefore \boxed{b = 5.42 r} \quad \#$$

$$\therefore \text{for } R = \frac{A}{P} = \frac{3br - 0.43 r^2}{5.14 r + b}$$

$$\therefore R = \frac{3 \times 5.42 r^2 - 0.43 r^2}{5.14 r + 5.42 r^2} = \frac{15.83 r^2}{10.56 r}$$

$$\boxed{R = 1.50 r} \quad \#$$